Lock-in Common Mode Rejection Demodulation (CMRD) Photothermal Measurements of Thermophysical Properties of Solids and Fluids

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Case studies of a recently developed signal common-mode rejection demodulation (CMRD) signal methodology (Mandelis et al., Rev. Sci. Instrum., 71, 2440 (2000)) will be presented. A procedure to calibrate the experiment will be described in order to take into account instrumental phase shifts between the reference and the optical excitation waveform. In fluids, the new technique has been used to make direct absolute thermal diffusivity measurements in liquids, using a thermal-wave cavity. This new methodology combines the precision of the thermal-wave cavity-scan and the flexibility of modulation-frequency scan modes, along with baseline suppression, yielding a high-resolution technique for thermal diffusivity measurements in liquids. The thermal diffusivity of two pure liquids (distilled water and ethylene glycol) has been measured and good agreement has been obtained with values reported in the literature. In solids, the method has been implemented experimentally with thermal waves in a photothermal radiometric apparatus. Some preliminary results obtained on Zr-2.5 Nb shot peened samples will be presented and compared to those obtained by temporally modulating the pump laser intensity as a 50% duty cycle square wave. The comparison shows the new measurement methodology to be a very promising technique for precise thermophysical measurements and depth profiling applications. The CMRD methodology will be shown to feature high detectivity for low-dynamic range and poor signal-to-noise ratio signals, such as those generated in thermophysics research involving thermal waves.